Polycyclic Aromatic Hydrocarbons in Dusts that Settled at Indoor and Outdoor locations in Lower Manhattan after 11 September 2001

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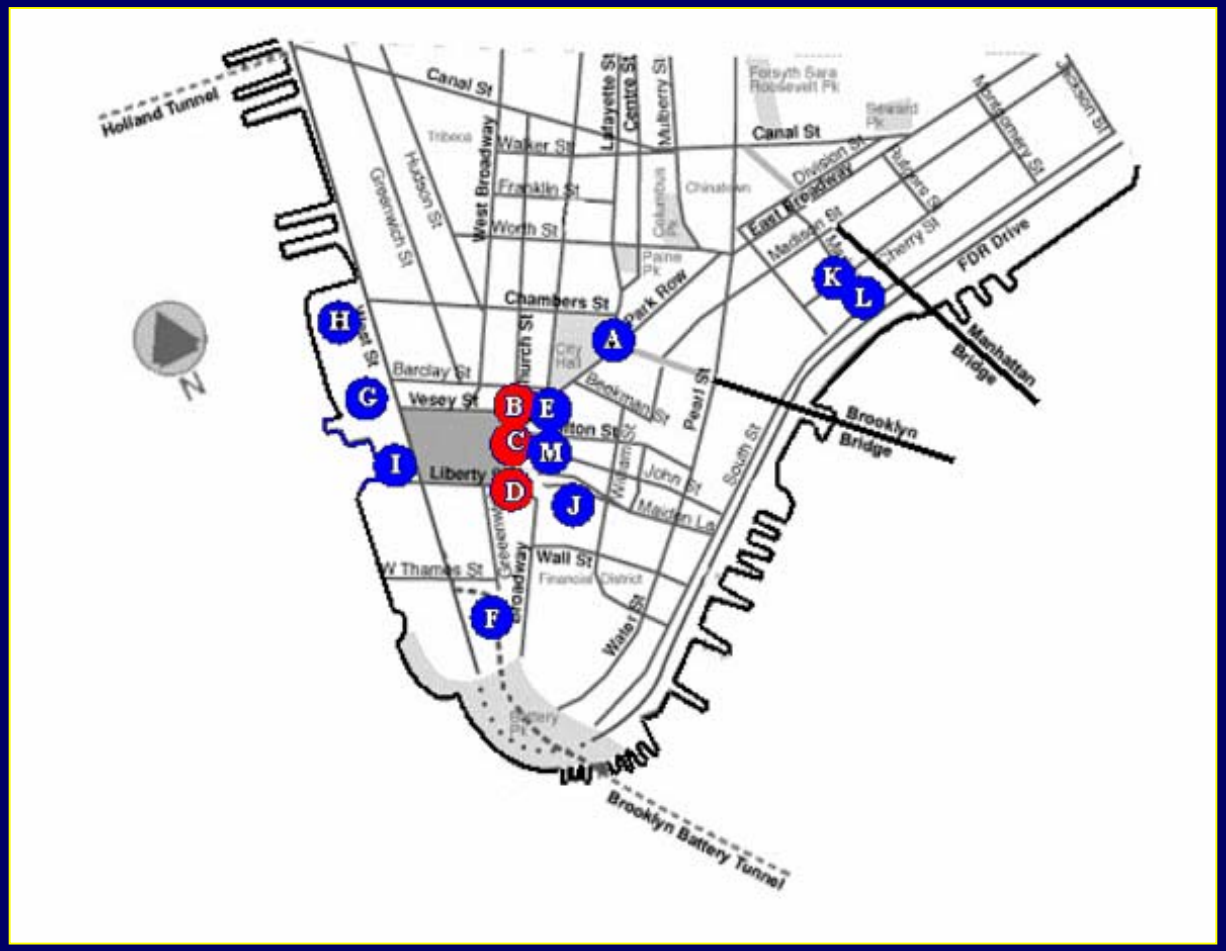
Why analyze the dusts?

The identification of major contaminants in settled WTC dust/smoke is important for assessing the potential for short and/or long term health effects from inhalation exposure of re-suspendable WTC dust/smoke due to the events of 9-11.

Outdoor samples collected from across lower Manhattan



Sampling: NYU 12 & 13 Sept. & EOHSI 16 & 17 Sept.
Red = Bulk analysis only; Blue = Size Segregated
K, L &M – analyzed for PCBs & OCPs in addition to PAHs

Samples collected from indoor locations in lower Manhattan

11 bulk, settled dust samples were collected from indoor locations on 19 November 2001 by EOHSI/NYU.

Contents of a vacuum cleaner ‘Post rehabilitation’ were collected on 22 April 2002.

Analytical Methods

Solvent Extraction:

- Dichloromethane 30 minute sonication

  Bulk: 3 x's ~0.7 g extracted *Separate for PAHs & PCB/OCPs*

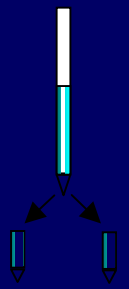
  Size Segregated: as available

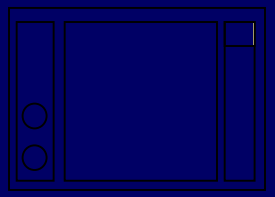
Fractionation/Cleanup (for PCB analysis on Bulk samples only):

- Column chromatography

  3% H_20 deactivated alumina

  - Fraction #1: PCBs/OCPs (Hexane)
  - Fraction #2: OCPs (2:1 DCM:Hexane)





Analysis:

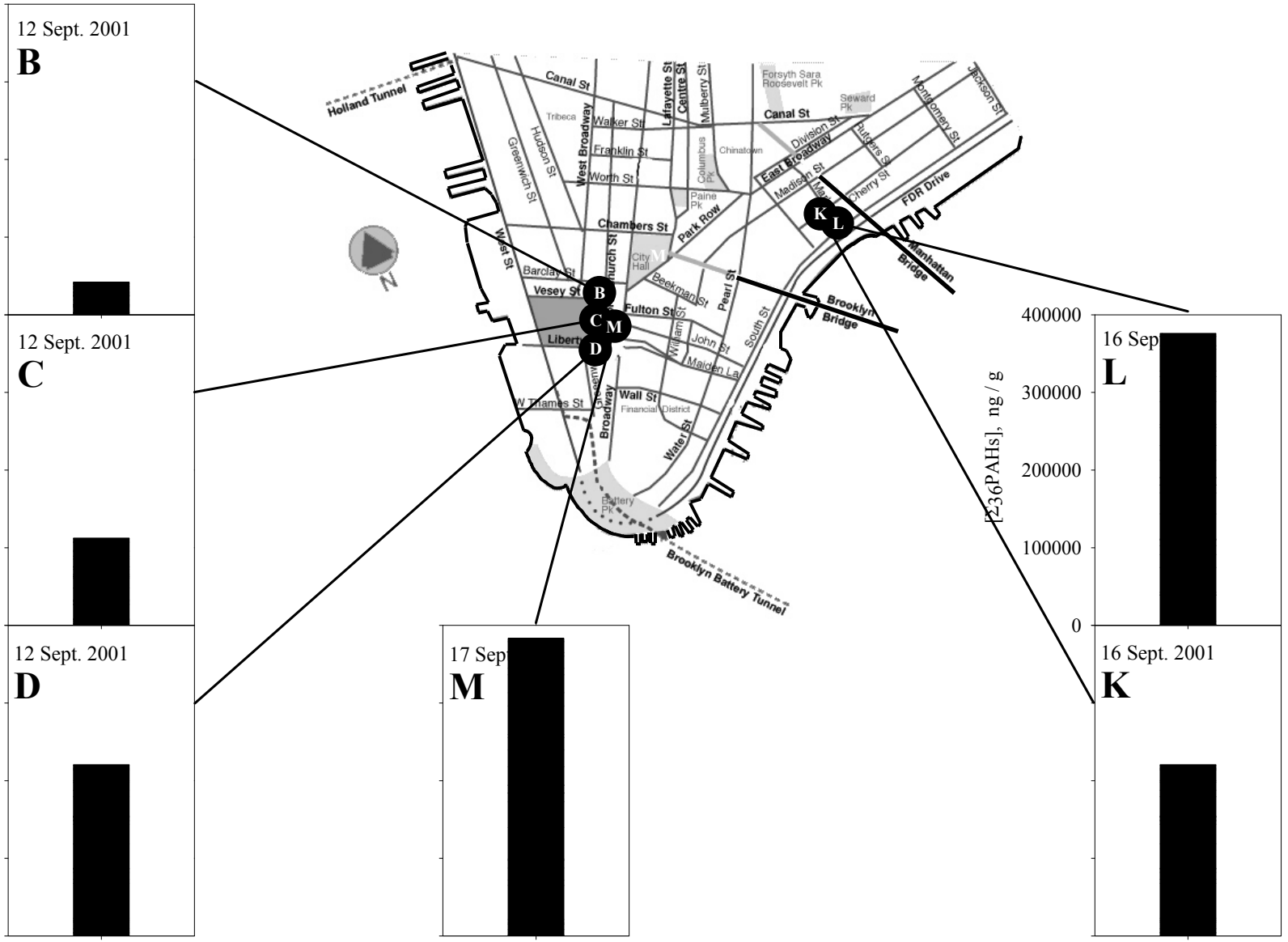
Gas Chromatography (HP 6890 Series)

(HP-5 Capillary column)

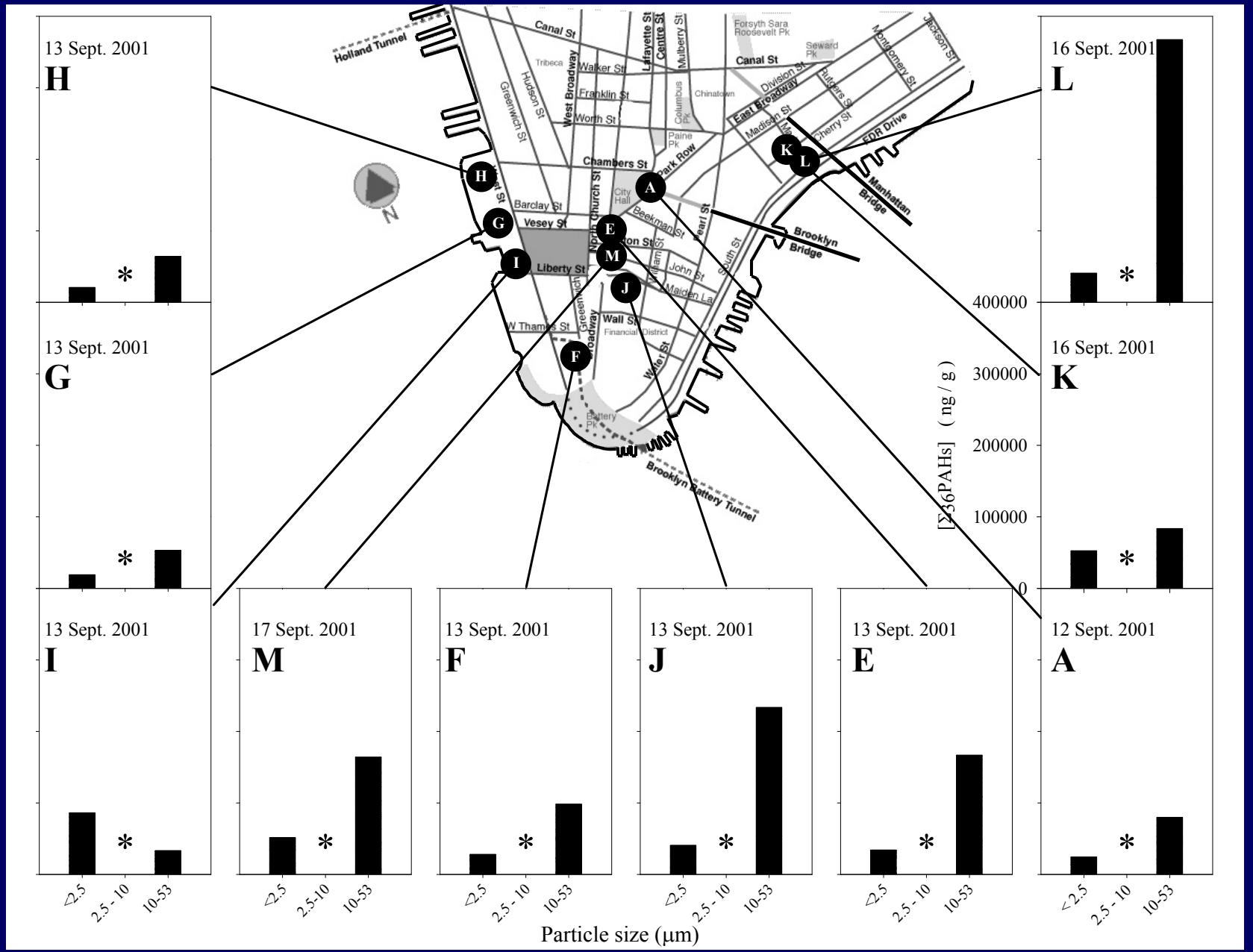
- Electron Capture Detector (μ-ECD) – PCBs and OCPs
- GC-MS (EI) in SIM mode - PAHs & Chlordanes

For details see Brunciak et al. (2001) and Gigliotti et al. (2001)

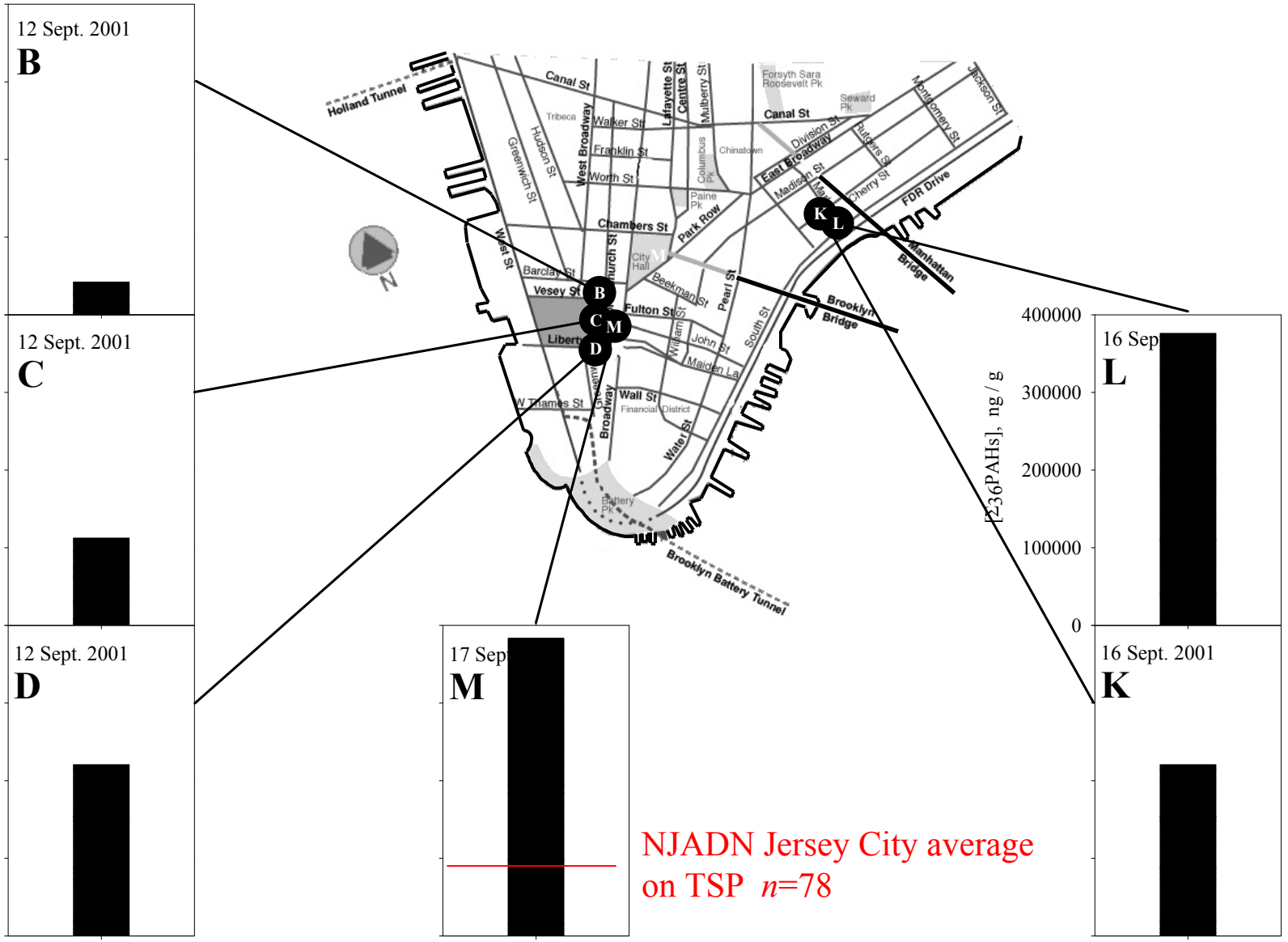
[Σ_{36}-PAHs] in bulk settled dusts



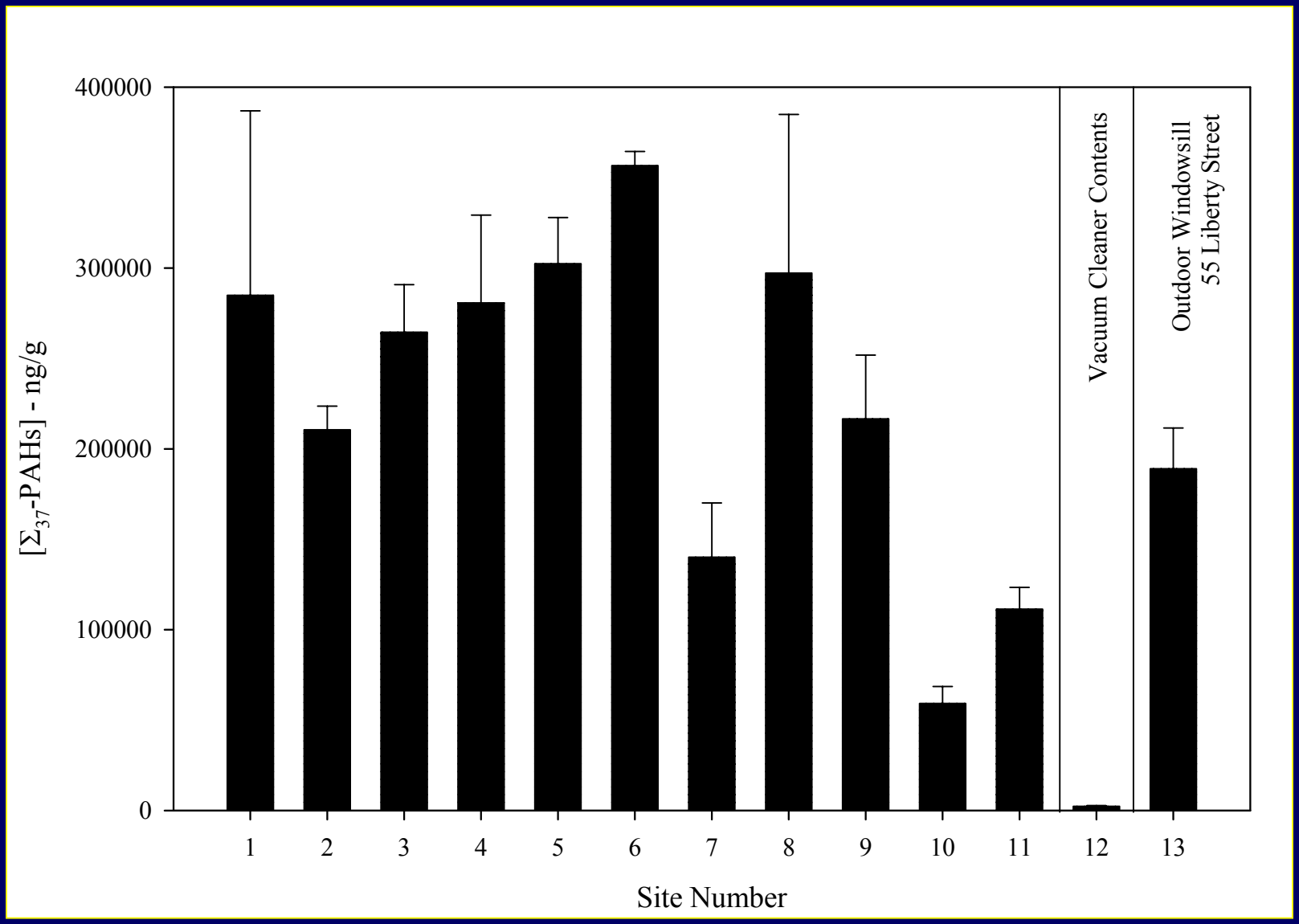
[Σ_{36}- PAHs] in Size Segregated Dusts

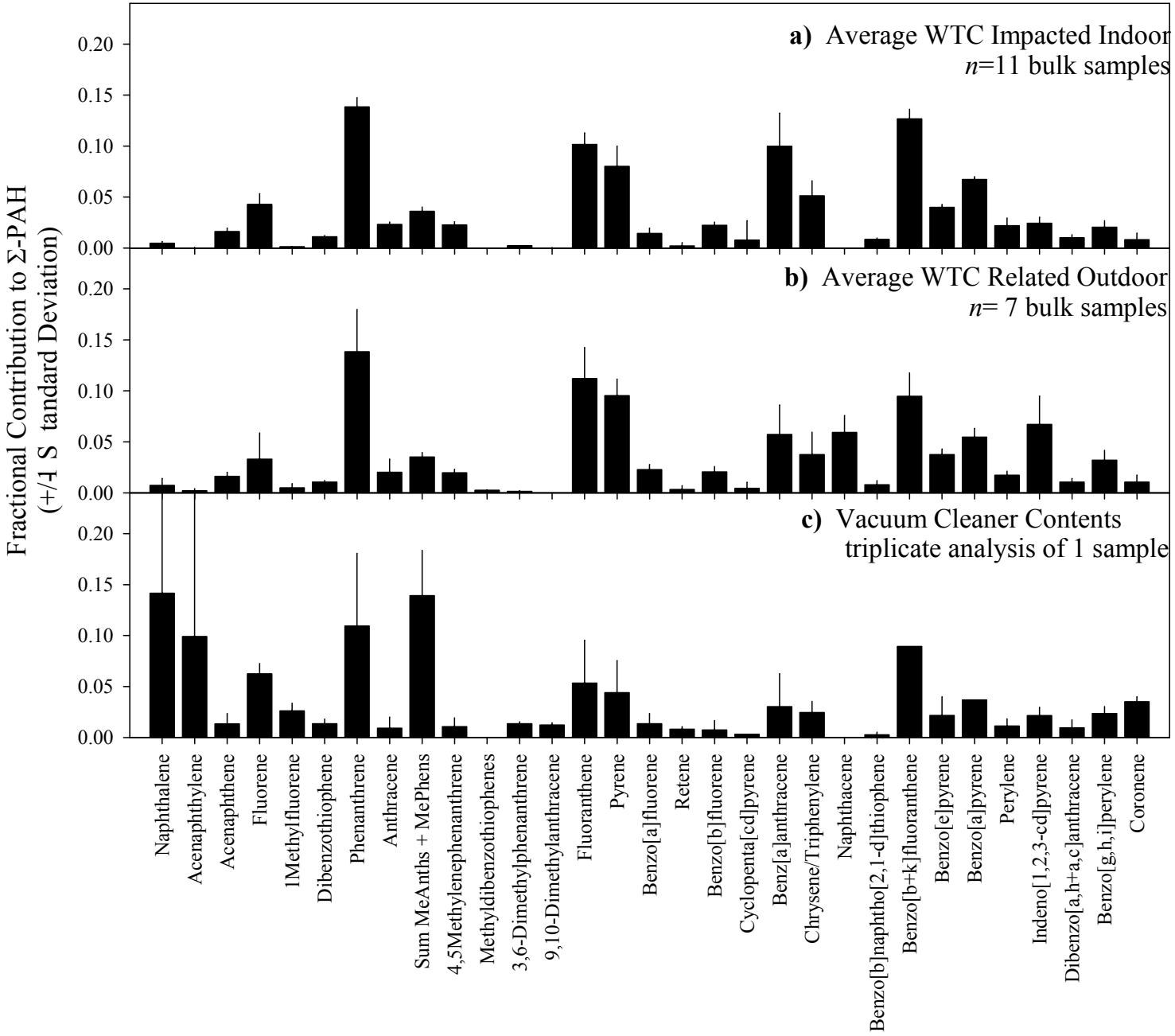


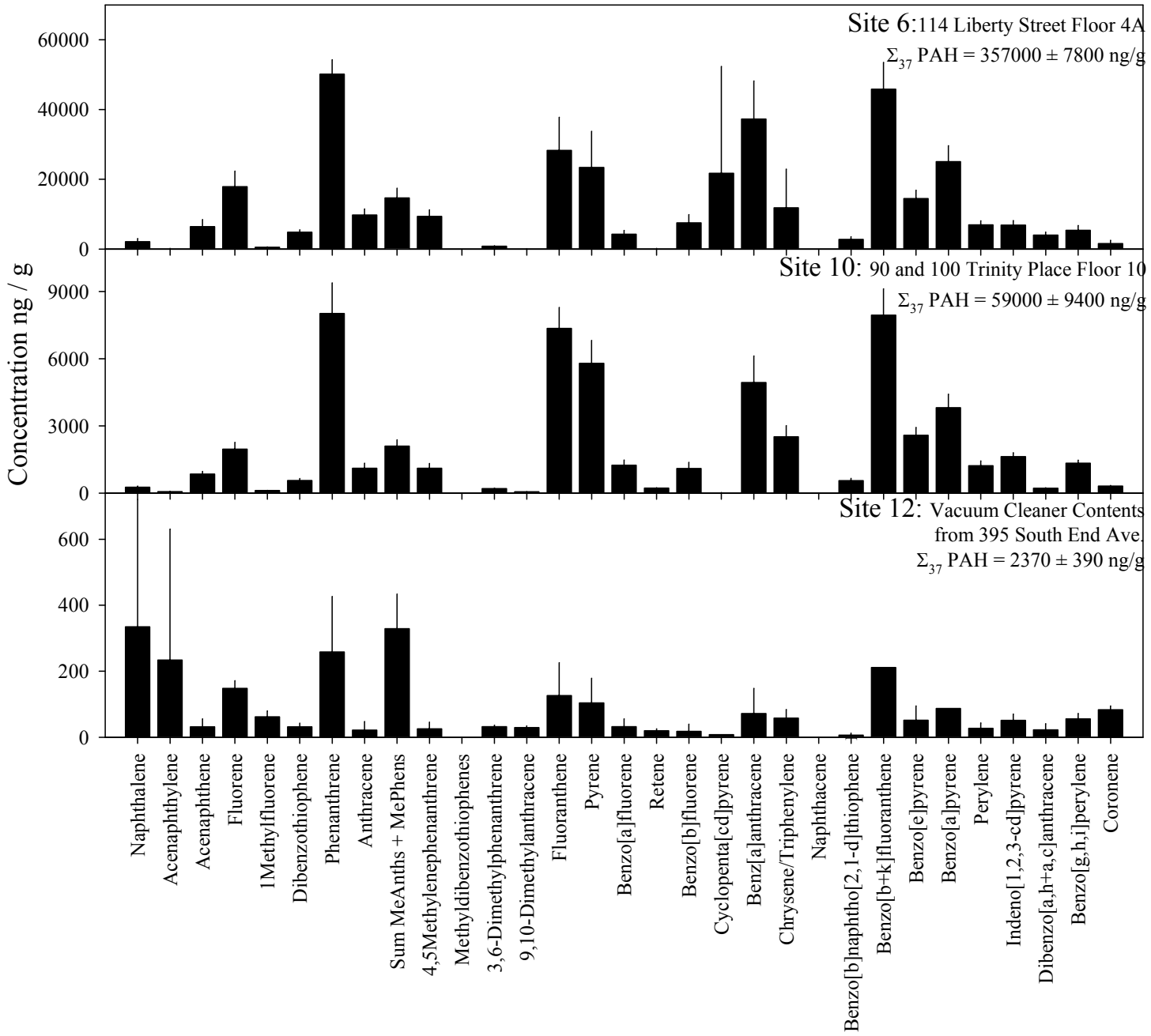
[Σ_{36}-PAHs] in bulk settled dusts



[Σ_{37}-PAH] at in bulk settled dusts collected at indoor locations




a) Average WTC Impacted Indoor
n=11 bulk samples
b) Average WTC Related Outdoor
n= 7 bulk samples
c) Vacuum Cleaner Contents
triplicate analysis of 1 sample
Fractional Contribution to Σ-PAH
(+/4 S tandard Deviation)
0.00
0.05
0.10
0.15
0.20
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
1Methylfluorene
Dibenzothiophene
Phenanthrene
Anthracene
Sum MeAnths + MePhens
4,5Methylenephenanthrene
Methyldibenzothiophenes
3,6-Dimethylphenanthrene
9,10-Dimethylanthracene
Fluoranthene
Pyrene
Benzo[a]fluorene
Retene
Benzo[b]fluorene
Cyclopenta[cd]pyrene
Benz[a]anthracene
Chrysene/Triphenylene
Naphthacene
Benzo[b]naphtho[2,1-d]thiophene
Benzo[b+k]fluoranthene
Benzo[e]pyrene
Benzo[a]pyrene
Perylene
Indeno[1,2,3-cd]pyrene
Dibenzo[a,h+a,c]anthracene
Benzo[g,h,i]perylene
Coronene


Site 6:114 Liberty Street Floor 4A
Σ_{37} PAH = 357000 ± 7800 ng/g
Site 10: 90 and 100 Trinity Place Floor 10
Σ_{37} PAH = 59000 ± 9400 ng/g
Site 12: Vacuum Cleaner Contents from 395 South End Ave.
Σ_{37} PAH = 2370 ± 390 ng/g
Concentration ng / g
60000
40000
20000
0
9000
6000
3000
0
600
400
200
0
Naphthalene
Acenaphthylene
Acenaphthene
Fluorene
1Methylfluorene
Dibenzothiophene
Phenanthrene
Anthracene
Sum MeAnths + MePhens
4,5Methylenephenanthrene
Methyldibenzothiophenes
3,6-Dimethylphenanthrene
9,10-Dimethylanthracene
Fluoranthene
Pyrene
Benzo[a]fluorene
Retene
Benzo[b]fluorene
Cyclopenta[cd]pyrene
Benz[a]anthracene
Chrysene/Triphenylene
Naphthacene
Benzo[b]naphtho[2,1-d]thiophene
Benzo[b+k]fluoranthene
Benzo[e]pyrene
Benzo[a]pyrene
Perylene
Indeno[1,2,3-cd]pyrene
Dibenzo[a,h+a,c]anthracene
Benzo[g,h,i]perylene
Coronene

Conclusions: Outdoor Dusts

Settled dusts contained up to 0.04% by mass of Σ_{36}-PAHs

Initial estimates indicate that ~1 x 10^6 tons of dust / aerosol were released due to the disaster.

This translates into ~100 to ~1000 tons of PAHs released into lower Manhattan following September 11th, even without considering continuing fires.

Conclusions: Indoor Dusts

Dusts that settled at indoor locations appear to have been of similar concentrations of PAH's as the dusts that settled outdoors.

In addition to similar concentrations, comparison of PAH concentration patterns (i.e. chemical fingerprints) shows that dusts that settled indoors are chemically similar to WTC dusts found at outdoor locations and that analysis of PAHs may be useful in identifying dusts of WTC origin at indoor locations.

Acknowledgements

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Finally, the authors would like to express our sympathy and continuing concern for the survivors and for the families of the victims of September 11, 2001.